16.4 2005 BSAI Sculpins

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16.4.0 Executive Summary

The following appendix summarizes the information currently known about sculpins (Family: Cottidae) in the Bering Sea/Aleutian Islands (BSAI) FMP.

a) 16.4.0.1 Summary of Major Changes

1. Total fishery catch data from 2004 and for 2005 to date are presented for the sculpin complex. Data are broken down for sculpins for the following genera: *Hemilepidotus, Myoxocephalus, Hemitripterus.* The rest of the sculpin species found in the BSAI are all reported as sculpin unidentified. Their data are also presented.
2. Information on total sculpin catch by target fishery and gear type for 2004.
3. Annual Alaska Fisheries Science Center (AFSC) bottom trawl survey biomass estimates from the eastern Bering Sea (EBS) shelf are presented for selected sculpin species.
4. Length frequencies of the 5 most abundant sculpin species are presented from AFSC survey data of the EBS shelf and the 3 most abundant species of the AI.
5. Authors recommend splitting the BSAI sculpin complex into a Bering Sea assemblage and an Aleutian Island assemblage. Therefore, we suggest separate ABC and OFL for each region (BSAI ABC and OFL given for comparison).

Region	M	Exploitable biomass (mt)	F_{ABC}	ABC (mt)	F_{OFL}	OFL (mt)
BSAI	0.19	206,882	0.1425	29,481	0.19	39,307
EBS	0.19	192,446	0.1425	27,423	0.19	36,565
AI	0.19	14,436	0.1425	2,057	0.19	2,743

b) 16.4.0.2 Responses to SSC Comments

The SSC requests that the author provide a rationale for splitting the complex into a shelf and slope complex in the Bering Sea. If the complex is lightly harvested the SSC questions whether spatial management is necessary at this time. The SSC encourages the authors to further their analysis of the implications of managing sculpins as Aleutian Island and Bering Sea assemblages. The difference in species composition between the Aleutian Islands region and the Bering Sea region provides a rationale for further consideration of this division. The SSC also notes that the plan to develop a pilot fishery ecosystem plan for the Aleutian Island region may provide an additional reason for considering separate management for the two regions.

Under section 16.4.4 Analytical Approach portion of the assessment a section has been added called Assemblage Analysis. This section discusses the author's rationale for splitting the sculpin complex biomass into a Bering Sea biomass assemblage and an Aleutian Island biomass assemblage.

While the SSC endorsed the use of a natural mortality rate of 0.19 for sculpins in the December 2004 minutes, the SSC requests that the authors further explain their rationale for selecting the lowest estimate of M for use in setting the tier 5 calculations.

A section discussing the rationale for selecting the lowest estimate of M for sculpins is included under the Parameters Estimated Independently section. Table 16.4.12 shows the various natural mortality estimates by species for a variety of sources, the 0.19 natural mortality rate is the most conservative option which is from the most reliable resource available.

The SSC requests that the authors consider the implications of adopting species specific ABCs and OFLs with respect to CDQs and changes to monitoring programs that may be required to adequately manage the sculpin assemblages.

It is not the intention of the authors to split out the sculpin assemblage to species. We currently do not have sufficient information to do this, nor do we have the rationale to support a split to species. If a target fishery were to be developed, then the authors would consider single species management. Furthermore, we only have catch estimates for 3 genera of sculpin, to adequately do single species assessments we would need individual catch estimates by species.

16.4.1 Introduction

Description, scientific names, and general distribution

Sculpins are relatively small, benthic-dwelling predatory teleost fish, with many species in the North Pacific. During the cooperative U.S.-Japan surveys, 41 species of sculpins were identified in the Eastern Bering Sea (EBS) and 22 species in the Aleutian Islands (AI) region. Sculpin diversity remains high from recent surveys of both areas (Table 16.4.1). Considered as a species complex, sculpins are distributed throughout all benthic habitats from shallow to deep, rocky to flat in the Bering Sea and Aleutian Islands (BSAI), such that they would cover any map of the area completely. In this assessment, we focus on species from the genera *Myoxocephalus*, *Hemitripterus*, and *Hemilepidotus* where observers from the North Pacific Groundfish Observer Program have begun to identify sculpin catch to genus. According to observer catch totals for 2004, the aforementioned genera contributed nearly 90% of all sculpin catch in the BSAI.

Management units

Sculpins are managed as part of the BSAI Other species complex. This means that their catch is reported in aggregate as “other” along with the catch of sharks, skates, and octopi (BSAI) and squid (GOA). Because catch is officially reported within the Other species complex, estimates of sculpin catch must be made independently for each year using observer data. In the BSAI, catch of other species is limited by a Total Allowable Catch (TAC) which is based on an Allowable Biological Catch (ABC) estimated by the average catch of all other species combined from 1977-present (Fritz, 1997). In the GOA, the TAC of other species has been established as 5% of the sum of the TACs for all other assessed target species in the GOA (Gaichas et al., 1999). Sculpins are currently taken only as bycatch in fisheries directed at target species in the BSAI, so future catch of sculpins is more dependent on the distribution and limitations placed on target fisheries than on any harvest level established for this category. The Other species assessment is also presented in response to recently proposed revisions in the National Standard Guidelines (NSG1, 70 FR 36240, June 22, 2005) of the Magnuson-Stevens Act that call for species assemblage management and the possibility of partitioning the Other species chapter into species assemblage management units.

Life history and stock structure (general)

Despite their abundance and diversity, sculpin life histories are not well known in Alaska. Much of the life history information comes from studies in the western North Pacific. In terms of life history, sculpins are different from many target groundfish species in that they lay adhesive eggs in nests, and many exhibit parental care for eggs (Eschemeyer et al., 1983). Markevich (2000) observed the sea raven, *Hemitripterus villosus*, releasing eggs into crevices of boulders and stones in shallow waters in Peter the Great Bay, Sea of Japan. This type of reproductive strategy may make sculpin populations more sensitive to changes in benthic habitats than other groundfish species such as pollock, which are broadcast spawners with pelagic eggs. Some larger sculpin species such as the great sculpin, *Myoxocephalus polyacanthocephalus*, reach sizes of greater then 80 cm in the eastern Bering Sea. In the western Pacific, great sculpins are reported to have relatively late ages at maturity (5-8 years, Tokranov, 1985) despite being relatively short-lived (13-15 years), which suggests a limited reproductive portion of the lifespan relative to other groundfish species. Fecundity for the great sculpin off East Kamchatka waters ranged from 48,000 to 415,000 eggs (Tokranov, 1985). In addition, the diversity of sculpin species in the FMP areas suggests that each sculpin population might react to similar environmental changes (whether natural or fishing influenced) in different ways. Within each sculpin species, observed spatial differences in fecundity, egg size, and other life history characteristics suggest local population structure (Tokranov, 1985), which is very different from wide ranging species such as sharks. All of these characteristics indicate that sculpins as a group might be managed separately from the other species complex, and perhaps most efficiently within a spatial context rather than with a global annual aggregate TAC.

Life history (BSAI-specific)

Information such as depth range, distribution, and maximum length has been collected for several years for many species during surveys. There is no BSAI-specific age and growth, maturity, or reproductive biology data for sculpins identified in this management region. To date, only the life history of the threaded sculpin, *Gymnocanthus pistilliger*, along the EBS shelf has been investigated beyond basic information in the BSAI (Hoff 2000). Some preliminary age data, however, may be available by the end of 2005 for several sculpin species collected during past surveys. Known life history characteristics for the most abundant sculpin species along the EBS shelf are presented in Table 16.4.2, data from the BSAI presented as available. Note that all fecundity and maturity data are from outside BSAI region.

16.4.2 Fishery

Directed fishery

There is no directed fishing for any sculpin species in the BSAI at this time.

Background on sculpin bycatch

Skates and sculpins constitute the bulk of the other species catches, accounting for between 66-96% of the estimated totals in 1992-1997. Based on total catch estimates from 1997-2005 (Table 16.4.3), sculpins comprised an average of 26% of the total Other species catch during this time period (skates, approx. 70%). Sculpins are caught by a wide variety of fisheries, but trawl fisheries for yellowfin sole, Pacific cod, pollock, Atka mackerel and flathead sole, and Pacific cod hook-n-line fishery catch the most (Gaichas et al. 2004).

It is likely that the larger sculpin species (Irish lords, *Hemilepidotus* spp., great sculpin and plain sculpins, *Myoxocephalus* spp., and bigmouth sculpin *Hemitripterus bolini*), which contribute to the majority of sculpin biomass on surveys, are the species commonly encountered incidentally in groundfish fisheries. It is unclear which sculpin species were commonly taken in BSAI groundfish fisheries up to 2004, because observers did not regularly identify animals in these groups to species. At least 80% (by weight) of the observed sculpin catch in past years was recorded as "sculpin unidentified", with the remainder of catch identified to the genus level (*Hemilepidotus, Myoxocephalus, Gymnocanthus, etc.*). Only small amounts (<2%) of sculpin catch in past years were identified to species, although observers were not specifically trained for this level of identification.

In 2002-2003, the observer program of AFSC initiated a species identification project prompted by the need to gather basic population data for groups in the Other species complex. Beginning in January 2004, sculpin catch was identified to genus for the larger sculpin species: *Hemilepidotus, Myoxocephalus, and Hemitripterus.* Several species of *Hemilepidotus* and *Myoxocephalus* have been identified from surveys. In the BSAI region, *Hemitripterus* probably represents only one species, the bigmouth sculpin (Stevenson 2004). Another member of this genus that may occur in Alaskan waters, the sea raven (*H. villosus*), has never been identified in any of the BSAI shelf and slope trawl surveys conducted by AFSC. It is reasonable to assume that all sculpins identified by observers as *Hemitripterus* sculpins were bigmouth sculpins.

16.4.3 Data

Fishery Catch

Catch trend by genus is not available before 2004. Refer to Table 16.4.3 for total sculpin catch from 1997-2005. Table 16.4.4 shows that *Myoxocephalus* spp. make up 49% of the sculpin total catch, with 87% of its catch in the EBS. *Hemilepidotus* spp. make up 27% of the observed sculpin catch, with its catch split 74% and 26% in the EBS and AI, respectively. *Hemitripterus* spp. (bigmouth sculpin) is primarily caught in the EBS. All other sculpin species, identified as “sculpin unidentified’ contributed only 11% of the total sculpin catch in 2004. Similar catch estimate proportions are found in the 2005 catch data through early October. The catch to biomass ratio of the 2004 total catch of sculpin by genus group, relative to the 2004 biomass estimates from the surveys is shown in the following table:

Genus	**EBS (shelf)**	**AI**
Myoxocephalus spp.	0.02	0.25
Hemitripterus spp.	0.02	0.12
Hemilepidotus spp.	0.04	0.01

Total sculpin catch by genus was calculated for each target fisheries and gear types responsible for sculpin bycatch (Table 16.4.5). Looking at the catch data by target fishery and gear type shows that in the Aleutian Islands both the Pacific cod and Atka mackerel bottom trawl fisheries were the main fisheries that caught all three genera of sculpin. In the EBS the Pacific cod bottom trawl and longline fisheries were the main fisheries that caught all three genera of sculpin. In general, gear type rather than target fishery may be the main determinant for sculpin bycatch. Since bottom trawl gear accounted for much of the sculpin bycatch regardless of fishery.

Survey Biomass trend

Aggregate sculpin biomass in the BSAI shows no clear trend, and should probably not be used as an indicator of population status for a complex with so much species diversity. Trends in biomass are available for only a few sculpin species for the period 1982-2004 due to difficulties with species identification and survey priorities. The species composition of the sculpin complex as estimated by bottom trawl surveys of the EBS shelf, EBS slope, and AI demonstrates the diversity of this complex and the regional differences in its composition. The larger species dominate the EBS shelf, with *Myoxocephalus* spp. being the most common, followed by bigmouth sculpins and yellow Irish lords (Table.16.4.6).

Tables 16.4.7-16.4.10 show biomass estimates of the most abundant sculpin species from annual EBS shelf surveys. The *Myoxocephalus* spp. group had biomass estimates to genus through 2000 before being separated by species. From 1982-1999 the *Myoxocephalus* spp. complex biomass was stable (Table 16.4.7). The *M. polyacanthocephalus* and *M. verrucocus* biomass estimates have been stable since 2000, and *M. Jaok* biomass has been slightly increasing (Table 16.4.7, Figure 16.4.1). Table 16.4.8 shows the *Hemilepidotus* species since 1982. Biomass estimates seem to be declining since 1982, with the exception of the biomass in 1986 where it showed a large increase. The butterfly sculpin (*H. papilio*) biomass estimate was assessed beginning in 1999 and has been declining since (Figure 16.4.1). This decline may be due to the *H. papilio* being a northern species while the EBS shelf survey samples the southern tip of its range. Bigmouth sculpin, the only species in the *Hemitripterus spp.* category, has been increasing since 1982 (Table 16.4.9). The biomass of spinyhead sculpin, *Dasycottus setiger*, has been variable over the past 20 years, with a peak biomass in 2005 of 4,469 mt (Figure 16.4.1). Other sculpins have a shorter biomass trend to assess. Biomass estimates have been available for two *Gymnocanthus* species, *G. galeatus* (armorhead sculpin) and *G. pistilliger* (threaded sculpin) since 1997 (Table 16.4.10). It is difficult to conclude if there is a natural variability in their biomass estimates or if there is a slight decline. It is also difficult to assess the trend for two other sculpin species, *Triglops pingeli* (ribbed sculpin) and *Icelus spiniger* (thorny sculpin) (Figure 16.4.1). It must be noted that most of the coefficient of variations (CVs) for the above biomass estimates suggest that the EBS shelf survey is doing an adequate job assessing the biomass of these species.

Sculpin species identification was only recently implemented in the AI survey. The five most abundant species of sculpin in the AI have estimates since 1997 (except Great sculpin). In the AI, yellow Irish lords account for the highest proportion of sculpin biomass, followed by darkfin sculpins, great sculpin, spectacled sculpin, bigmouth sculpin and scissortail sculpins (Table 16.4.11). The spectacled and scissortail sculpins are two species not found on EBS surveys. The AI survey adequately assesses the biomass of the 5 most abundant sculpin species, which are the larger species of sculpin. The smaller species coefficient of variation vary from 0.31 to 1.00. These smaller species probably elude the gear used during the bottom trawl survey. Biomass trends of sculpin species in the AI seem to be stable. (Figure 16.4.2).

Length frequency and sample size

Eastern Bering Sea

Length measurements (fork length, FL) have been collected for a variety of sculpin species during AFSC surveys. The five most abundant species from the EBS shelf survey have been measured annually since 2000: yellow Irish lord, plain sculpin, warty sculpin, great sculpin and bigmouth sculpin (Figure 16.4.3). Year by year analysis shows that the length composition by species is consistent. One interesting observation is that the surveys tend to catch bigmouth sculpins on the higher side of the length range. Although little information is known about bigmouth sculpin life history, this may suggest that the younger or smaller bigmouth sculpins occur in areas not sampled well by the surveys.

Sample sizes for length frequency analysis for EBS

Species	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Yellow Irish Lord				369	516	604
Plain sculpin	1044	1263	997	1218	1736	1786
Warty sculpin	178	288	130	192	245	323
Great sculpin	338	327	346	635	681	786
Big mouth sculpin	50	157	231	179	342	187

Aleutian Islands

In the AI, few samples have been taken for great and bigmouth sculpin, thus the length frequency analysis does not yield a complete representation of the sculpin species population's size composition. Yellow Irish lords have 3 survey years of data and show a consistent size composition (Figure 16.4.4). Darkfin and spectacled sculpin only have length data collected from the 2002 survey. Specimens smaller than 7 cm have not been collected for many sculpins, but this may be a factor of size selectivity of the survey gear. Spectacled sculpin population may have a bi-modal size distribution, with peaks at 13 cm and 19 cm.

Sample sizes for length frequency analysis for AI

Species	**2000**	**2002**	**2004**
Yellow Irish Lord	170	567	986
Darkfin sculpin	-	193	-
Spectacled sculpin	-	145	-
Great sculpin	12	23	58
Big mouth sculpin	8	29	27

<u>Length at age and weight at age</u>

At this time we do not have any age data for sculpins. The Age and Growth group at the AFSC is currently working up a small sample size of otoliths from the EBS shelf survey for spinyhead, thorny, great, plain, warty, spectacled and bigmouth sculpins. Ages will be available in 2006.

16.4.4 Analytical Approach and Results

The available data do not currently support population modeling for sculpins in the BSAI, although natural mortality (M) was estimated (refer to 2004 SAFE).

Parameters Estimated Independently

Natural Mortality

An analysis was undertaken to explore alternative methods to estimate natural mortality (M) for sculpin species found in the BSAI. Several methods were employed based on correlations of M with life history parameters including growth parameters (Alverson and Carney 1975, Pauly 1980, Charnov 1993), longevity (Hoenig 1983), and reproductive potential (Roff 1986, Rikhter and Efanov 1976). Little information was available for sculpin stocks in the BSAI FMP area, so M was estimated using reproductive potential methods applied to data for Russian sculpin species (Rikhter and Efanov 1976). Considering the uncertainty inherent in applying this method to sculpin species and stocks not found in the BSAI, we elected to use the lowest estimates of M derived from any of these methods (Table 16.4.12). Choosing the lowest estimate of M is considered conservative because it will result in the lowest estimates of ABC and OFL under Tier 5. Until we find better information on sculpin productivity in the BSAI, this is still the best interim measure balancing sculpin conservation and allowing for historical levels of incidental catch in target groundfish fisheries.

Assemblage analysis and recommendations

Currently all sculpin species from the BSAI are lumped into one complex. Analysis of species composition, abundance and occurrence of endemic species within the EBS and AI was done to determine if the complex should be split by region. Species composition in the EBS and AI are different. Although a few species such as *Myoxocephalus polyacanthocephalus*, *Hemilepidotus jordani*, and *Hemitripterus bolini* occur in both the EBS and AI regions, their biomass estimates vary greatly (Table 16.4.6 and 16.4.11). For example *Hemitripterus bolini* biomass in the EBS is an order of magnitude greater than in the AI. In both regions endemic species are also found. *Myoxocephalus jaok* and *M. verucosus* only occur on the EBS shelf. In the AI *Artediellus forficata* and *Enophrys diceraus* may be endemic. Overall, though, the main rationale for splitting the sculpin complex biomass into an AI and BS complex is due to the difference in the fishery catch relative to their biomass. Perhaps due to a higher density of sculpins in the EBS, their catch to biomass ratio is 0.04 or less. Whereas, in the AI, the catch to biomass ratio of the genera Myoxocephalus and Hemitripterus are 0.25 and 0.12 respectively. This difference may suggest that sculpin bycatch in the AI fisheries are of more concern than in the EBS. Lastly, there is some evidence that the catch of sculpins are spatially explicit (Figure 16.4.5). Splitting the biomass to obtain separate ABC and OFL for each region will allow for adequate monitoring of those species in the AI.

16.4.5 ABC and OFL recommendations

It is obvious that leaving sculpins within the larger aggregate of the other species complex provides no benefit to these fish or to the fisheries that might wish to retain some other species but cannot when the aggregate TAC is exceeded, as it was in 2004. For 2005, the Other species TAC was set at 24,650 mt and has not been exceeded. According to the Alaska Regional Office (http://www.fakr.noaa.gov/2005/car110_bsai_without_cdq.pdf) through October 15, 2005, total catch of the Other species complex was 20,881 mt. Because sculpins are such a diverse category themselves, and because their life history is so different from skates, sharks, and octopi as described above, we recommend that they be managed separately from the other species complex. There is a reliable biomass time series for the sculpin complex as a whole, and recently reliable estimates of biomass for each species within the complex. We feel that our conservative estimate of M is the best available for managing this species complex until the research initiated in the Bering Sea is completed.

For the time being, we recommend a Tier 5 approach be applied to the sculpin complex within the EBS and AI regions as long as the catch remains incidental and no target fishery develops. We further recommend using a 10 year average of aggregate biomass so that we may include multiple estimates from each of the EBS shelf, slope, and AI bottom trawl surveys, but capture recent biomass trends. In tier 5, F_{ABC} is defined to be $<=0.75$ x M and F_{OFL} is defined to be equal to M. Applying the M estimate of 0.19 to the 10 year average of bottom trawl survey biomass estimates by region, we calculate an ABC of 0.75 * 0.19 * (EBS shelf + EBS slope) = 27,423 mt for the EBS and we calculate an ABC of 0.75 * 0.19 * (AI biomass) = 2,057 mt. Using the same method to calculate OFL, 0.19 * (EBS shelf + EBS slope) = 36,565 mt for the EBS and for the AI an OFL of 0.19 * (AI biomass)= 2,743 mt. Tier 6 options for sculpin management are not recommended.

In the unlikely event that target fisheries develop for some sculpin species, we recommend that each targeted sculpin species be managed separately, and that directed fishing only be allowed when sufficient life history information becomes available to make reasonable species specfic estimates of productivity. Given that the most probable targeted sculpin species would be the most abundant, managing as single species may not be problematic under the current TAC setting regime, assuming the species was being identified to species level by the observer program. If a targeted species of sculpin is one with a low abundance thus low TACs, then alternative management strategies such as closed areas should be considered.

16.4.6 Ecosystem Considerations

16.4.6.1 Ecosystem Effects on Stock

Little is known about sculpin food habits in the BSAI, especially during fall and winter months. Limited information indicates that in the EBS the larger sculpin species prey on shrimp and other benthic invertebrates, as well as some juvenile walleye pollock (Figure 16.4.6). In the EBS the main predator of large sculpins are Pacific cod, but the greatest mortality of large sculpins is due to the flatfish bottom trawl fishery (Figure 16.4.6). Other sculpins in the EBS feed mainly on shrimp and benthic amphipods (Figure 16.4.7). Other sculpins are preyed upon by pinnipeds, Pacific cod and small demersal fish, but their main source of mortality is from consumption by eelpouts, wintering seals and the Alaska skate (Figure 16.4.7). In the AI large sculpin have a different diet than in the EBS, consisting of crabs, Atka mackerel and miscellaneous shallow water fish (Figure 16.4.8). Large sculpin in the AI are preyed upon mainly by Pacific halibut, but the main source of their mortality is from “other” groundfish bottom trawl fishery (Figure 16.4.8). Diet of other sculpins in the AI consists of polychaetes and benthic amphipods (Figure 16.4.9). Pacific cod and walleye pollock are the main predators of other sculpins and are the main source of mortality of other sculpins in the AI (Figure 16.4.9). Source of above information from Aydin et al. (in review).

16.4.6.2 Fishery Effects on the Ecosystem

Analysis of ecosystem considerations for those fisheries that effect the stocks within this complex (see Table 16.4.5) is given in the respective fisheries SAFE chapter. The BSAI Sculpin complex is not a targeted fishery, therefore reference to the effects of the fishery on the ecosystem will be described in those chapters of the fisheries that catch sculpins incidentally.

Ecosystem effects on *Sculpin complex*			
Indicator	Observation	Interpretation	Evaluation
Prey availability or abundance trends			
Zooplankton	Stomach contents, ichthyoplankton surveys, changes mean wt-at-age	No affect	Probably no concern
a. Predator population trends			
Marine mammals	Fur seals declining, Steller sea lions increasing slightly	No affect	Probably no concern
Birds	Stable, some increasing some decreasing	No affect	Probably no concern
Fish (Pollock, Pacific cod, halibut)	Stable to increasing	Affects not known	Probably no concern
b. Changes in habitat quality			
Temperature regime	None	Affects not known	Unknown
Winter-spring environmental conditions	None	Probably a number of factors	Unknown
Production	Fairly stable nutrient flow from upwelled BS Basin	Inter-annual variability low	No concern
***Targeted fisheries* effects on ecosystem (see relative chapters)**			

16.4.6.3 Data gaps and research priorities

Severe data gaps exist in sculpin species life history characteristics, spatial distribution and abundance. These data are necessary in deciding creative management strategies for non-target species. Collecting seasonal food habits data (with additional summer collections) would help to clarify the role of both large and small sculpin species within the BSAI ecosystem. It is essential that we continue to improve species identifications as well as collecting life history information important for effective stock management. Nearly 90% of all sculpins caught in the fisheries of the BSAI in 2004 were from the genera *Myoxocephalus*, *Hemitripterus*, and *Hemilepidotus*. At this time, there is still no BSAI-specific age and growth and maturity data for any species in these genera.

16.4.7 Summary

Below are the recommendations for ABC and OFL for an EBS sculpin complex and AI sculpin complex. BSAI numbers are there for reference.

Summary Table for Tier 5 Sculpin Complex

Region	**M**	**Exploitable biomass (mt)**	**F_{ABC}**	**ABC (mt)**	**F_{OFL}**	**OFL (mt)**
BSAI	0.19	206,882	0.1425	29,481	0.19	39,307
EBS	0.19	192,446	0.1425	27,423	0.19	36,565
AI	0.19	14,436	0.1425	2,057	0.19	2,743

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Table 16.4.1. Members of the Sculpin complex observed during the years 1995-2004 on eastern Bering Sea and Aleutian Islands bottom trawl surveys.

Family	Scientific name	Common name
Cottidae	*Archistes biseriatus*	Scaled sculpin
	Artediellus miacanthus	Bride sculpin
	Artediellus pacificus	Pacific hookear sculpin
	Bolinia euryptera	Broadfin sculpin
	Enophrys diceraus	Antlered sculpin
	Enophrys lucasi	Leister sculpin
	Gymnocanthus detrisus	Purplegray sculpin
	Gymnocanthus galeatus	Armorhead sculpin
	Gymnocanthus pistilliger	Threaded sculpin
	Gymnocanthus tricuspis	Arctic staghorn sculpin
	Hemilepidotus gilberti	Banded Irish lord
	Hemilepidotus hemilepidotus	Red Irish Lord
	Hemilepidotus jordani	Yellow Irish Lord
	Hemilepidotus papilio	Butterfly sculpin
	Hemilepidotus zapus	Longfin Irish lord
	Icelinus borealis	Northern sculpin
	Icelus canaliculatus	Blacknose sculpin
	Icelus euryops	Wide-eye sculpin
	Icelus spatula	Spatulate sculpin
	Icelus spiniger	Thorny sculpin
	Icelus uncinalis	Uncinate sculpin
	Jordania zonope	Longfin sculpin
	Leptocottus armatus	Pacific staghorn sculpin
	Myoxocephalus jaok	Plain sculpin
	Myoxocephalus polyacanthocephalus	Great sculpin
	Myoxocephalus quadricornis	Fourhorn sculpin
	Myoxocephalus verrucocus	Warty sculpin
	Radulinus asprellus	Slim sculpin
	Rastrinus scutiger	Roughskin sculpin
	Thyriscus anoplus	Sponge sculpin
	Triglops forficatus	Scissortail sculpin
	Triglops macellus	Roughspine sculpin
	Triglops metopias	Crescent-tail sculpin
	Triglops pingelii	Ribbed sculpin
	Triglops septicus	Spectacled sculpin
	Triglops xenostethus	Scalybreasted sculpin
	Zesticelus profundorum	Flabby sculpin
Hemitripteridae	*Blepsias bilobus*	Crested sculpin
	Hemitripterus bolini	Bigmouth sculpin
	Nautichthys oculofasciatus	Sailfin sculpin
	Nautichthys pribilovius	Eyeshade sculpin
Psychrolutidae	*Dasycottus setiger*	Spinyhead sculpin
	Eurymen gyrinus	Smoothcheek sculpin
	Malacoccottus zonurus	Darkfin sculpin
	Malacocottus kincaidi	Blackfin sculpin
	Psychrolutes paradoxus	Tadpole sculpin
	Psychrolutes phrictus	Blob sculpin
Rhamphocottidae	*Rhamphocottus richardsoni*	Grunt sculpin

Table 16.4.2. Life history information available for selected BSAI sculpin species.

Species	Common Name	Maximum Length (cm)			Maximum Age		Fecundity (x1000)	Age at 50% Maturity
		Other	AI	EBS	Other	BSAI		
Myoxocephalus joak	Plain sculpin	75	NA	63	15		25.4 - 147	5 - 8
M. polyacanthocephalus	Great sculpin	82	76	82	13		48 - 415	6 - 8
M. verrucosus	Warty sculpin	78	NA	78			2.7	
Hemitripterus bolini	Bigmouth sculpin	83	83	78				
Hemilepidotus jordani	Yellow Irish lord	65	65	50	13		25 - 241	6 - 7
H. papilio	Butterfly sculpin	38		38				
Gymnocanthus pistilliger	Threaded sculpin	27		20	13	10	5 - 41	
G. galeatus	Armorhead sculpin	46		36	13		12 - 48	
Dasycottus setiger	Spinyhead sculpin	45		34	11			
Icelus spiniger	Thorny sculpin	17		17				
Triglops pingeli	Ribbed sculpin	20			6		1.8	
T. forficata	Scissortail sculpin	30		30	6		1.7	
T. scepticus	Spectacled sculpin	25	25	NA	8		3.1	
Malacoccottus zonurus	Darkfin sculpin		30	NA				

References: AFSC; Panchenko 2002; Panchenko 2003; Tokranov 1985; Andriyashev 1954; Tokranov 1988a; Tokranov 1988b; Tokranov 1995; Tokranov and Orlov 2001.
Notes: Estimate of Natural mortality (M) is the lowest estimate of M derived from several methods as presented Table 16.4.12 and in the 2004 Other species SAFE chapter; Blanks indicate no life history data found.

Table 16.4.3. Total catch (mt) of sculpin complex compared to other species catch, 1997-2005.

Year	Other species ABC	Other species TAC	Other species OFL	Other species catch	EBS Sculpin catch	AI Sculpin Catch	% of Sculpin in Other spp. catch (EBS)	% of Sculpin in Other spp. catch (AI)
1997	25,800	25,800		25,176	6,707	771	27%	3%
1998	25,800	25,800	134,000	25,531	5,204	1,081	20%	4%
1999	32,860	32,860	129,000	20,562	4,503	967	22%	5%
2000	31,360	31,360	71,500	26,108	5,673	1,413	22%	5%
2001	33,600	26,500	69,000	27,178	6,067	1,603	22%	6%
2002	39,100	30,825	78,900	28,619	6,043	1,133	21%	4%
2003	43,300	32,309	81,100	28,703	5,351	598	19%	2%
2004	46,810	27,205	81,150	27,266	5,031	1,116	18%	4%
2005	53,860	29,000	87,920	19,857	4,483	549	23%	3%

sources: Other species ABC, TAC, OFL, and catch from AKRO website
BSAI skate catch 1992-1996 from Fritz 1996, 1997, 1997-2002 from Gaichas et al 2004
BSAI skate catch 2003-2005 from AKRO, *2005 data complete as of October 4, 2005

Table 16.4.4. Extrapolated total catch (mt) of *Hemilepidotus* spp., *Hemitripterus* spp. *and Myoxocephalus* spp. based on proportion of observed catch. *Source: NMFS AK regional office catch accounting system.*

2005*	**Eastern Bering Sea**	**Aleutian Islands**	**Total**
Hemitripterus spp. Bigmouth sculpin	306	18	**324**
Hemilepidotus spp.	1,208	399	**1,607**
Myoxocephalus spp.	2,500	54	**2,555**
Sculpin unidentified	468	77	**545**
Total	**4,483**	**549**	**5,032**

*Data reported through 10/04/2005

2004	**Eastern Bering Sea**	**Aleutian Islands**	**Total**
Hemitripterus spp. Bigmouth sculpin	648	92	**740**
Hemilepidotus spp.	1,373	489	**1,862**
Myoxocephalus spp.	2,479	379	**2,858**
Sculpin unidentified	526	156	**682**
Total	**5,026**	**1,116**	**6,142**

Table 16.4.5. Total catch (mt) of Large sculpins by target fishery and gear, from 2004 for Aleutian Islands and Eastern Bering Sea. *Source: NMFS AK regional office catch accounting system. Note: Amounts below do not add up to the total catch of the Sculpin complex.*

2004

Aleutian Islands

Large Sculpins

Target fishery	Gear type			
	Bottom Trawl	Pelagic Trawl	Pot	Longline
Pacific Cod	159	-	-	133
Flatfish	-	-	-	6
Rockfish	11	-	-	-
Atka Mackerel	378	-	-	-

2004

Eastern Bering Sea

Large sculpins

Target fishery	Gear type			
	Bottom Trawl	Pelagic Trawl	Pot	Longline
Pacific Cod	1,422	3	191	1,087
Pollock	5	111	-	-
Sablefish	1	-	-	-
Rockfish	<1	-	-	-
Flatfish	1,638	-	-	1
Atka Mackerel	42	-	-	-

Table 16.4.6. Sculpin complex biomass (mt) from the 2001-2005 Bering Sea shelf survey.

Sculpin species	**common**	**2001**	**2002**	**2003**	**2004**	**2005**
Myoxocephalus jaok	plain	48,400	52,525	79,337	68,671	76,540
Myoxocephalus polyacanthocephalus	great	39,815	64,881	64,486	58,505	55,957
Hemitripterus bolini	bigmouth	25,751	32,178	29,274	34,748	31,002
Hemilepidotus jordani	yellow irish lord	9,109	9,430	14,220	33,630	27,380
Myoxocephalus verrucosus	warty	15,023	10,801	7,058	10,089	25,897
Gymnocanthus pistilliger	threaded	423	1,560	1,137	1,275	1,977
Dasycottus setiger	spinyhead	1,681	1,194	1,274	1,019	4,469
Gymnocanthus galeatus	armorhead	289	1,708	720	785	1,551
Icelus spiniger	thorny	793	767	715	616	543
Triglops pingeli	ribbed	186	155	142	556	264
Hemilepidotus papilio	butterfly	1,649	686	628	379	370
Malacocottus zonurus	darkfin	220	529	11	122	35
Triglops macellus	roughspine	8	3	10	62	111
Triglops scepticus	spectacled	174	255	298	29	112
Icelus spatula	spatulate	16	19	3	13	20
sculpin unid (all others)		10	2	0	10	0
Artediellus pacificus	hookear sculpin	4	2	0	trace	3
Triglops forficata	scissortail sculpin	0	0	0	0	0
Leptocottus armatus	staghorn	0	0	0	0	210
Enophrys diceraus	antlered	0	0	0	0	0

Table 16.4.7. *Myoxocephalus* spp. biomass (mt) time series from EBS shelf bottom trawl surveys, 1982-2005.

Year	*Myoxocephalus* spp.		Great Sculpin *M. polyacanthocephalus*		Plain Sculpin *M. jaok*		Warty Sculpin *M. verrucocus*	
	Biomass	CV	Biomass	CV	Biomass	CV	Biomass	CV
1982	198,728	0.21						
1983	165,660	0.11						
1984	140,931	0.15						
1985	91,988	0.08						
1986	103,164	0.07						
1987	115,468	0.08						
1988	148,709	0.08						
1989	139,924	0.10						
1990	146,329	0.11						
1991	184,199	0.10						
1992	170,451	0.10						
1993	152,273	0.09						
1994	92,212	0.11						
1995	154,622	0.12						
1996	142,794	0.09						
1997	160,420	0.13						
1998	141,079	0.12						
1999	103,345	0.09						
2000			61,218	0.42	43,605	0.08	11,718	0.18
2001			39,815	0.28	48,400	0.10	15,023	0.16
2002			64,881	0.20	52,525	0.17	10,801	0.25
2003			64,486	0.20	79,337	0.09	7,058	0.17
2004			58,505	0.11	68,671	0.10	10,089	0.18
2005			55,957	0.10	76,540	0.10	25,897	0.52

Table 16.4.8. *Hemilepidotus* spp. biomass (mt) time series from EBS shelf bottom trawl surveys, 1982-2005.

Year	***Hemilepidotus* spp.**		**Yellow Irish Lord *H. jordani***		**Butterfly Sculpin *H. papilio***	
	Biomass	**CV**	**Biomass**	**CV**	**Biomass**	**CV**
1982	100,197	0.25	50,484	0.34		
1983	92,388	0.28	43,453	0.43		
1984	71,061	0.24	29,517	0.34		
1985	71,725	0.28	13,116	0.24		
1986	183,971	0.60	24,131	0.34		
1987	50,896	0.40	41,564	0.48		
1988	74,616	0.46	24,861	0.33		
1989	49,013	0.38	22,097	0.39		
1990	48,459	0.27	10,212	0.18		
1991	57,021	0.66	10,311	0.17		
1992	33,310	0.25	17,091	0.20		
1993	36,173	0.40	21,017	0.45		
1994	31,779	0.22	17,905	0.28		
1995	29,397	0.24	18,805	0.28		
1996	15,418	0.18	14,256	0.19		
1997	26,467	0.25	23,692	0.28		
1998	14,753	0.29	13,913	0.31		
1999	15,475	0.17	12,972	0.20	2,458	0.39
2000	13,374	0.19	11,037	0.22	2,327	0.41
2001	10,757	0.30	9,109	0.35	1,649	0.46
2002	10,144	0.32	9,430	0.35	686	0.52
2003	14,850	0.24	14,220	0.25	628	0.49
2004	34,009	0.33	33,630	0.33	379	0.43
2005	27,765	0.26	27,380	0.26	370	0.35

Table 16.4.9. *Hemitripterus bolini* and *Dasycottus setiger* biomass (mt) time series from EBS shelf bottom trawl surveys, 1982-2005.

Year	Bigmouth sculpin *Hemitripterus bolini*		Spinyhead sculpin *Dasycottus setiger*	
	Biomass	**CV**	**Biomass**	**CV**
1982	21,889	0.23	997	0.21
1983	18,648	0.22	487	0.31
1984	25,847	0.22	353	0.25
1985	14,219	0.22	241	0.28
1986	10,504	0.24	220	0.27
1987	23,082	0.18	255	0.38
1988	21,767	0.25	970	0.28
1989	16,696	0.22	662	0.28
1990	16,123	0.24	1,363	0.25
1991	20,680	0.23	2,169	0.17
1992	18,300	0.21	2,924	0.20
1993	19,307	0.18	1,756	0.19
1994	28,330	0.22	1,384	0.21
1995	29,393	0.18	1,247	0.36
1996	30,980	0.22	686	0.23
1997	29,434	0.17	850	0.19
1998	36,276	0.24	958	0.16
1999	24,437	0.18	1,471	0.27
2000	25,838	0.19	1,845	0.21
2001	25,751	0.16	1,681	0.23
2002	32,178	0.34	1,194	0.20
2003	29,274	0.14	1,274	0.18
2004	34,748	0.14	1,019	0.20
2005	31,002	0.13	4,469	0.31

Table 16.4.10. *Gymnocanthus galeatus, G. pistilliger, Triglops pingeli and Icelus spiniger* biomass (mt) time series from EBS shelf bottom trawl surveys, 1997-2005.

Year	Armorhead sculpin *Gymnocanthus galeatus*		Threaded sculpin *G. pistilliger*		Ribbed sculpin *Triglops pingeli*		Thorny sculpin *Icelus spiniger*	
	Biomass	**CV**	**Biomass**	**CV**	**Biomass**	**CV**	**Biomass**	**CV**
1997	1,251	0.46	3,867	0.24				
1998	916	0.65	1,801	0.23	71	0.35		
1999	250	0.43	3,572	0.20	220	0.54	998	0.25
2000	330	0.54	1,696	0.27	77	0.59	984	0.28
2001	289	0.44	423	0.30	186	0.44	793	0.27
2002	1,708	0.86	1,560	0.51	155	0.55	767	0.23
2003	720	0.67	1,137	0.35	142	0.23	715	0.22
2004	785	0.57	1,275	0.22	556	0.49	616	0.17
2005	1,551	0.79	1,977	0.26	264	0.34	543	0.17

Table 16.4.11. Sculpin complex biomass (mt) from the 1997-2004 Aleutian Islands trawl survey.

Species	**Common Name**	**Biomass**				**CV**
		1997	**2000**	**2002**	**2004**	**2004**
Hemilepidotus jordani	Yellow Irish lord	4,667	6,624	4,282	8,361	0.17
Malacocottus zonurus	Darkfin sculpin	3,442	2,533	3,971	4,493	0.14
Myoxocephalus polyacanthocephalus	Great sculpin	2,138	1,161	1,547	1,519	0.30
Triglops scepticus	Spectacled sculpin	1,344	1,121	2,393	1,038	0.21
Hemitripterus bolini	Bigmouth sculpin	1,617	1,026	1,191	790	0.29
T. forficata	Scissortail sculpin	219	66	442	2,073	0.47
Gymnocanthus galeatus	Armorhead sculpin	105	287	207	506	0.31
Sculpin unid. (all others)		75	49	137	101	0.24
Dasycottus setiger	Spinyhead sculpin	71	19	23	72	0.91
Enophrys diceraus	Antlered sculpin	0	0	20	17	0.55
	Plain sculpin	0	0	32	0	
Leptocottus armatus	Pacific staghorn sculpin	0	0	0	9	1.00

Table 16.4.12. List of available natural mortality information for sculpins.

Species	Area	Sex	Hoenig	Rikhter & Efanov	Alverson & Carney	Charnov	Roff
Arctic staghorn sculpin	W. Bering Sea	*males*	0.53				
	W. Bering Sea	*females*	0.47				
				0.41			
Common staghorn sculpin	Kamchatka	*males*	0.32	0.32			
	Kamchatka	*females*	0.25	0.26			
Red Irish Lord	Puget Sound		0.70				
Threaded sculpin	E. Bering Sea	*males*	0.42		0.36	0.65	
		females	0.47		0.58	0.40	
Armorhead sculpin	Kamchatka	*males*	0.38				
	Kamchatka	*females*	0.32				
Great sculpin	Kamchatka	*males*	0.47	0.32			
	Kamchatka	*males*		0.26			
	Kamchatka	*females*	0.32	0.22			
	Kamchatka	*females*		0.19			
Plain sculpin	Sea of Japan	*males*	0.35	0.41			
	Sea of Japan	*males*		0.32			
	Sea of Japan	*females*	0.28	0.26			
	Sea of Japan	*females*		0.22			

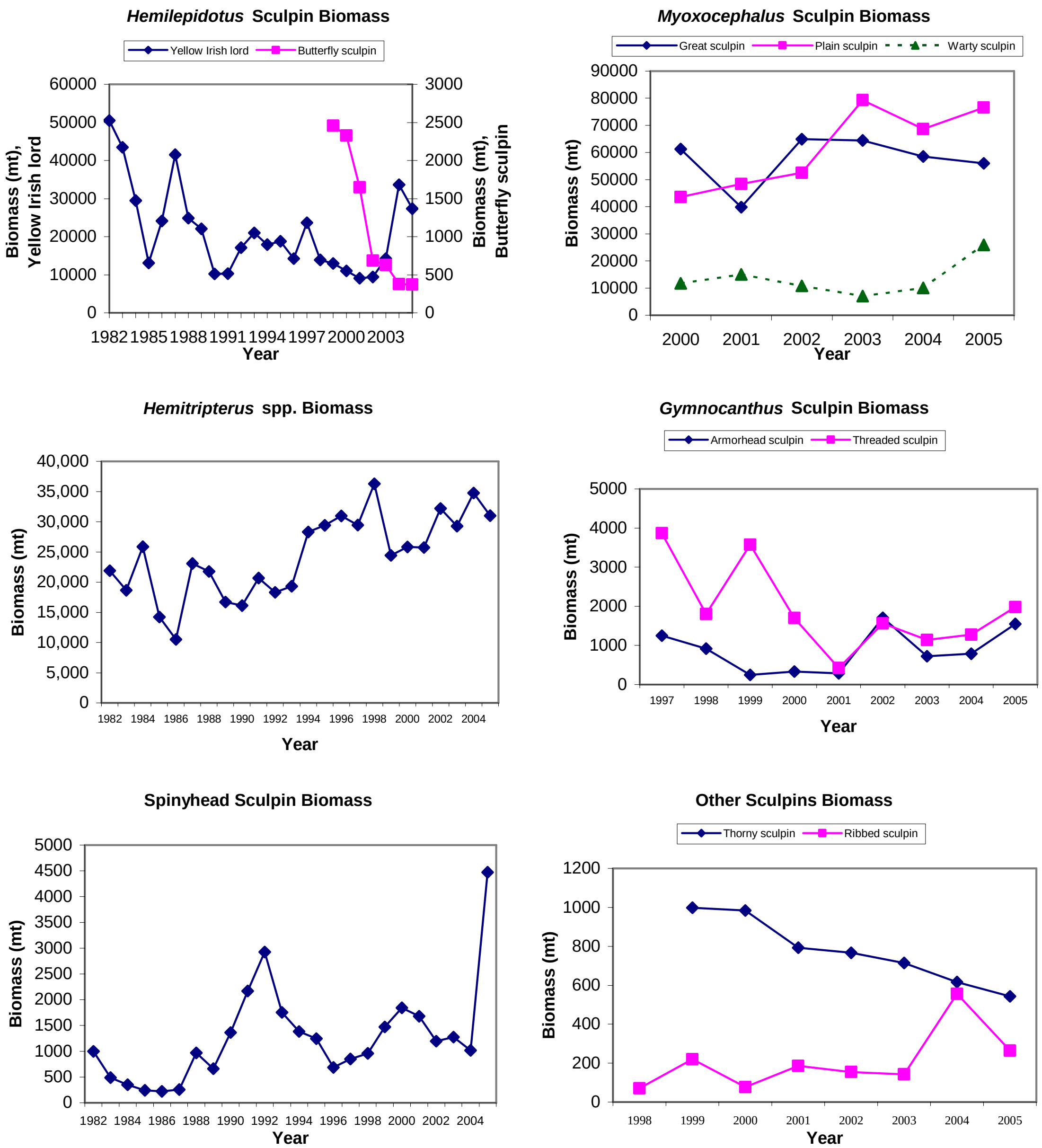

Figure 16.4.1. Biomass time series from EBS shelf bottom trawl surveys for selected sculpin species, 1982-2005.

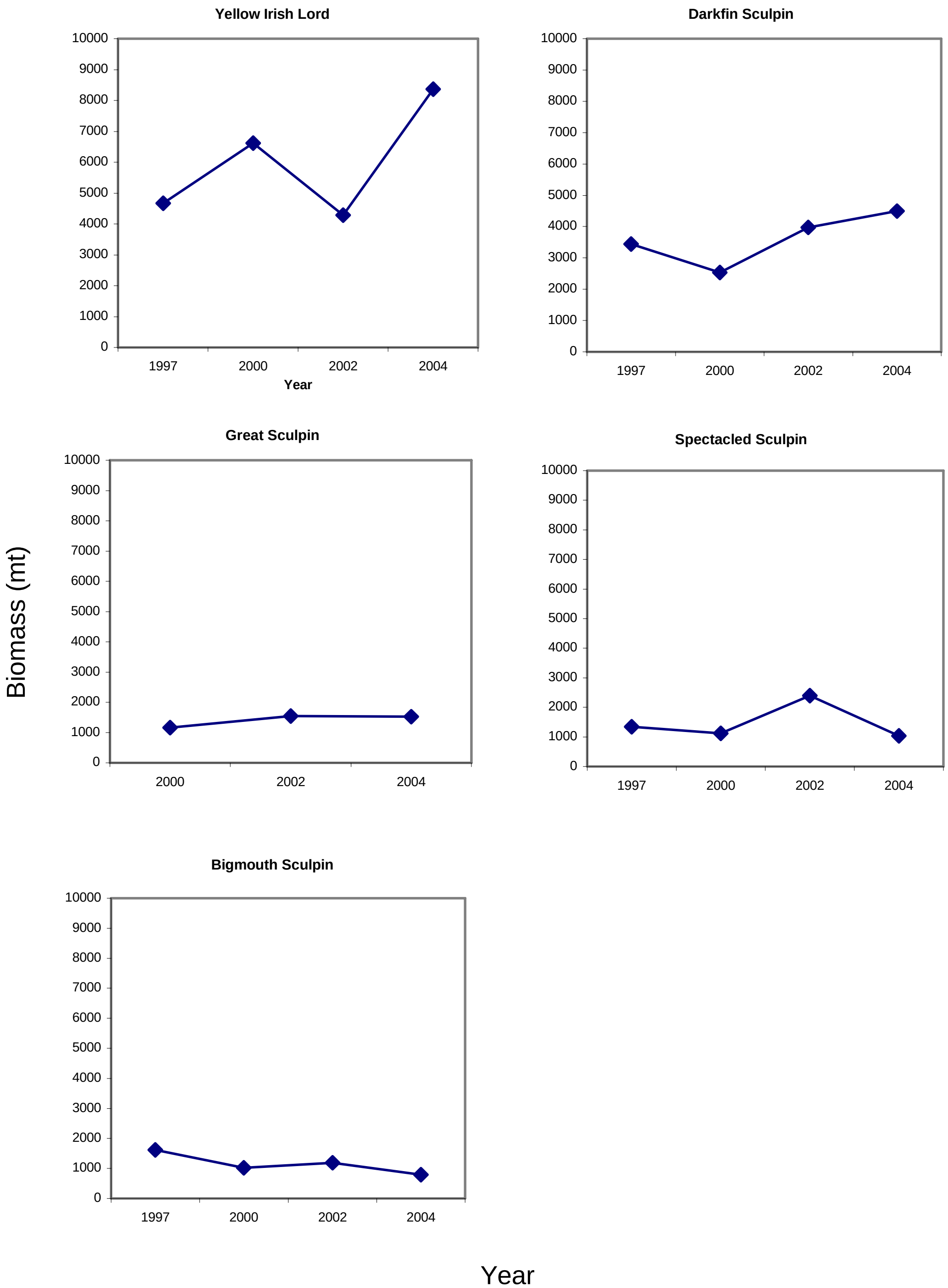

Figure 16.4.2 Biomass trends for five most abundant sculpin species in Aleutian Islands trawl survey 1997-2004. Note: Most sculpin species identified to species beginning in 1997 survey.

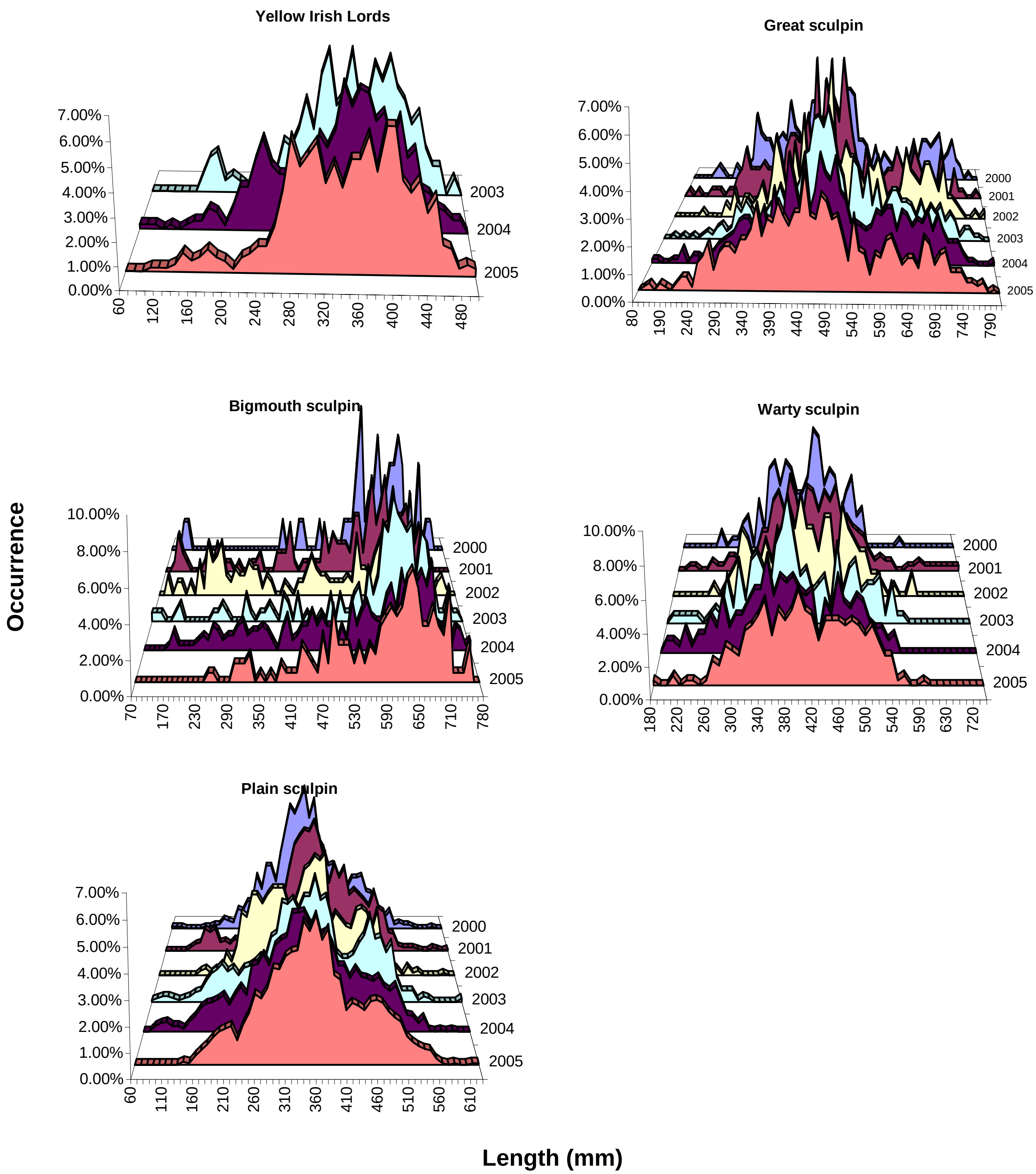

Figure 16.4.3. Length frequencies (fork length, FL in mm) from survey data for the five most abundant sculpin species in EBS. Note: Plain and warty sculpins found only on EBS shelf.

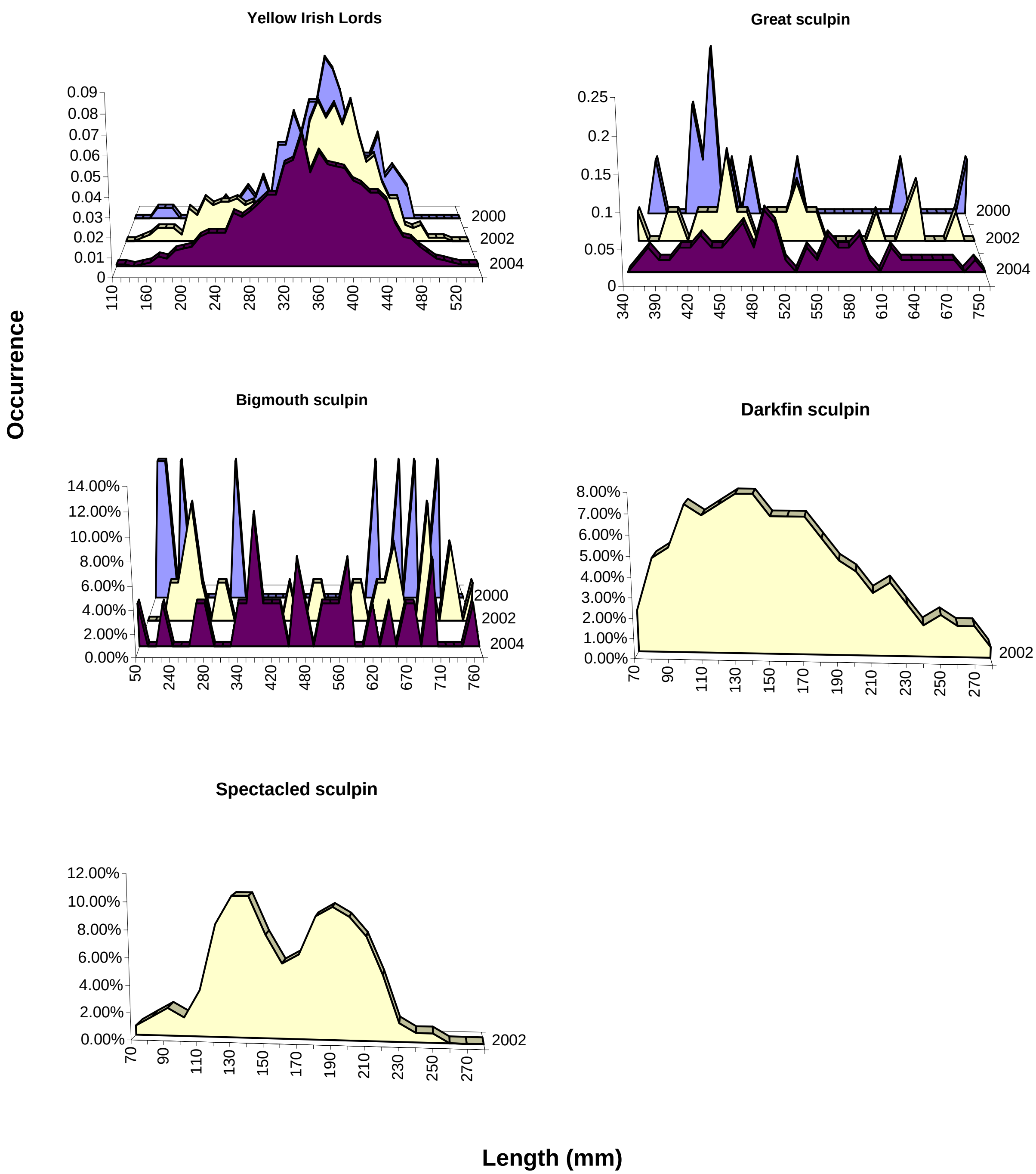

Figure 16.4.4. Length frequencies (fork length, FL in mm) from survey data for the 5 most abundant sculpin species in AI.

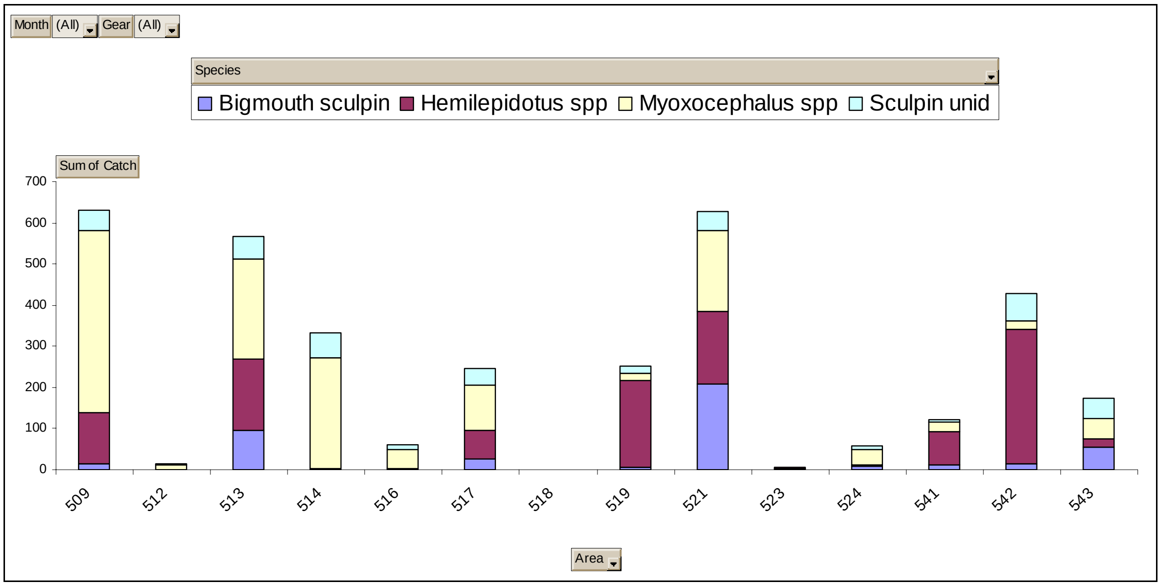

Figure 16.4.5. Observed sculpin catch by management area for the 3 observed genera from 2004. Note that the Hemitripterus family is made up only of Bigmouth sculpin.

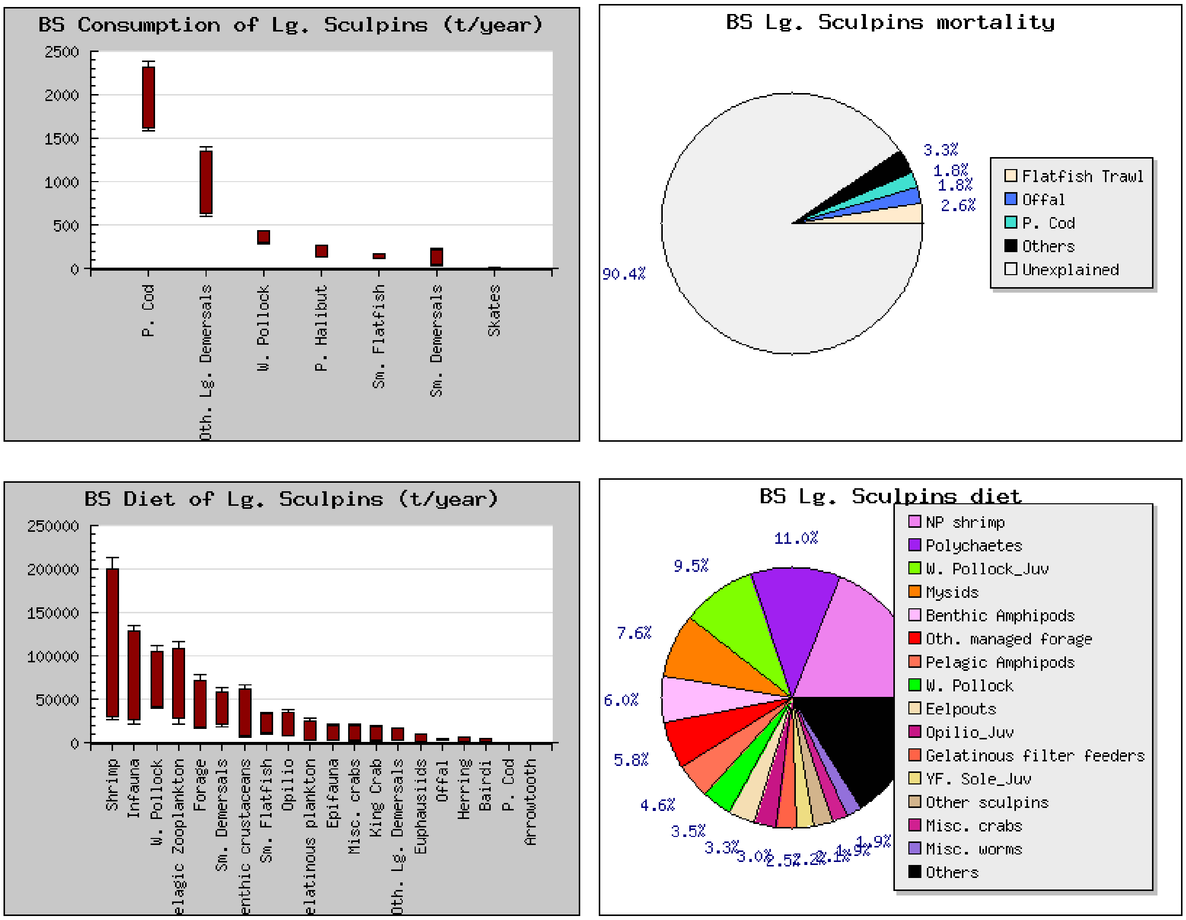

Figure 16.4.6. Figures showing Consumption, mortality, and diet of large sculpins from the Bering Sea. Source: REEM ecosystem website.

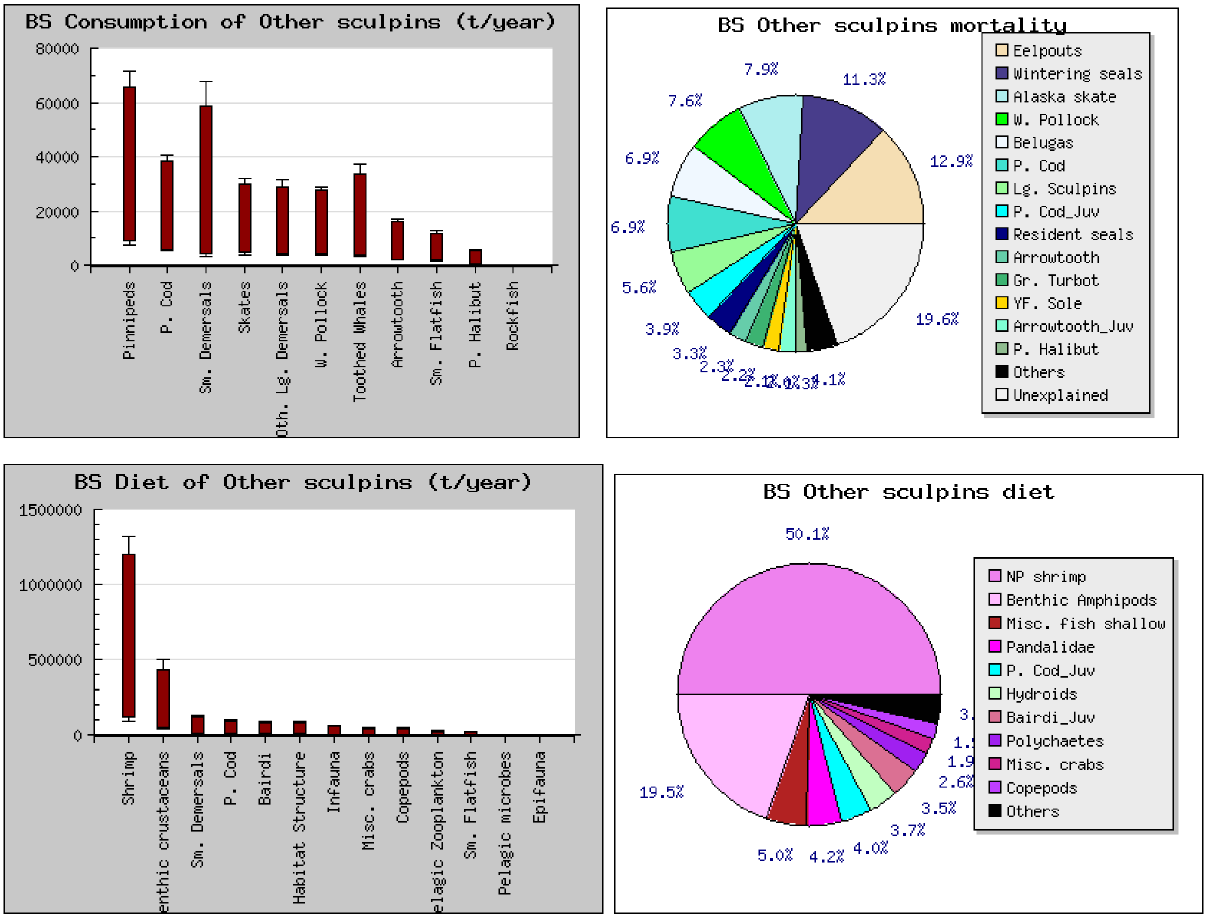

Figure 16.4.7. Figures showing Consumption, mortality, and diet of other sculpins from the Bering Sea. Source: REEM ecosystem website.

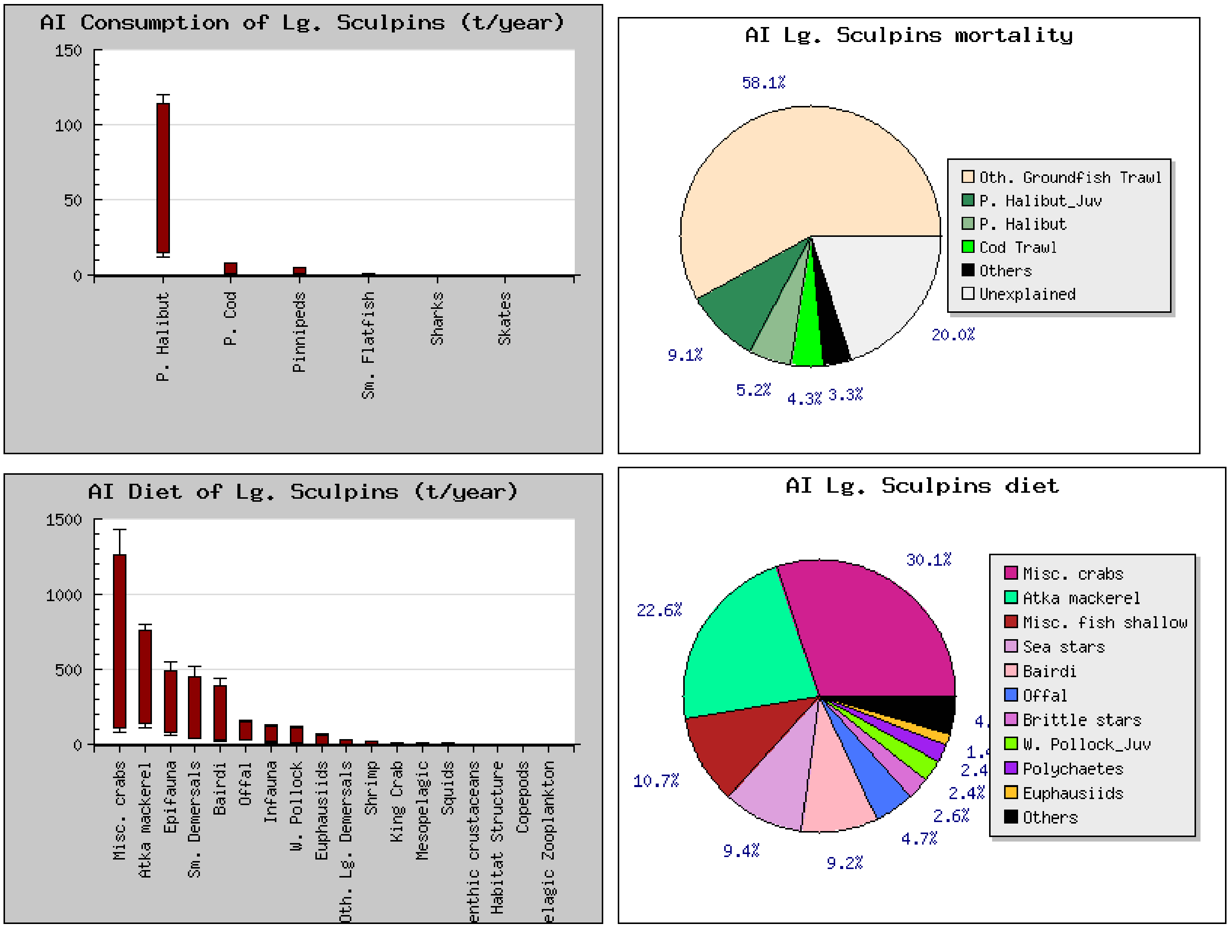

Figure 16.4.8. Figures showing Consumption, mortality, and diet of large sculpins from the Aleutian Islands. Source: REEM ecosystem website.

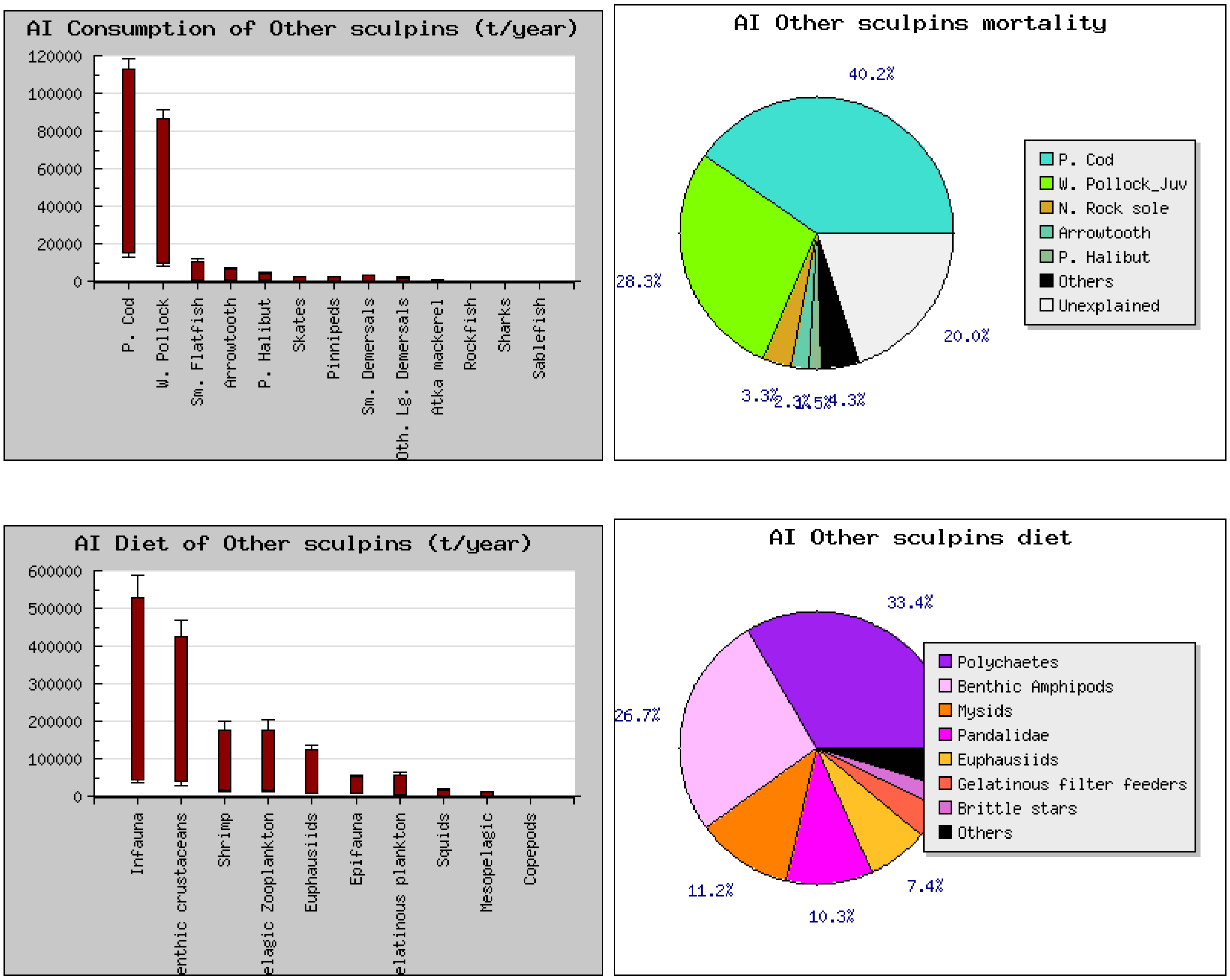

Figure 16.4.9. Figures showing Consumption, mortality, and diet of other sculpins from the Aleutian Islands. Source: REEM ecosystem website.

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